

REMARKS

By this Amendment, Applicants have removed the second reference to 410 in Figure 4 and corrected it to 412 as recommended by the Examiner. An annotated sheet and replacement sheet are included. This amendment to Figure 4 corrects a minor typographical error and does not introduce new matter. Claim 15 has been canceled without disclaimer. Claims 1, 14 and 16 have been amended to include, among other things, that the method, computer readable storage medium, or dynamic medical image include measuring the quality of the registration of the time separated images and determining a measure of the quality of registration of the time separated images from a calculated level of agreement. Support for the amendments to claims 1, 14, and 16 can be found in the specification, for example, at pages 7-9, and Figures 3-5. Applicants have also amended claim 14 to recite "a computer-readable storage medium carrying a computer program which causes the computer to execute" as recommended by the Examiner. No new matter has been added by this amendment. Applicants respectfully request entry of the amendment and allowance of the pending claims.

Claim Objection

The Examiner objected to claim 1 for the typographical error. Applicants have removed the "-" from claim 1. This objection is now moot.

Rejection under 35 U.S.C. §112, Second Paragraph

The Examiner rejected claim 1 as allegedly lacking antecedent basis for the phrase "the temporal behavior" and "the level of agreement". Applicants have amended claim 1 to recite antecedent basis for these phrases. Thus, Applicants submit that this rejection is now moot.

Rejection Under 35 U.S.C. § 101

Claims 14 and 15 are rejected under 35 U.S.C. §101 as allegedly directed to non-statutory subject matter. Applicants respectfully traverse this rejection.

The Examiner has the initial burden of showing that the claims are not directed to statutory subject matter. Applicants respectfully submit that the Examiner has not met the burden. Nevertheless, Applicants have amended claim 14 to recite “a computer-readable storage medium carrying a computer program which causes the computer to execute” as recommended by the Examiner. Applicants have also canceled claim 15 without disclaimer. Applicants respectfully submit that the claims fully comply with 35 U.S.C. §101 and request withdrawal of this rejection.

Rejections Under 35 U.S.C. §102(e)/103(a)

The Examiner rejects claims 1-5 and 11-16 under 35 U.S.C. 102(e) as allegedly being anticipated by Smith (US 2004/0064037). Claims 6-9 are rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Smith in view of Suri (US 6,718,055). Claim 10 is rejected under 35 U.S.C. 103(a) as allegedly being unpatentable over Smith in view of Suri and further in view of Hossack et al. (US 6,360,207). Applicants respectfully traverse these rejections.

To establish a *prima facie* case of anticipation or obviousness the Examiner has the burden of establishing that the cited references disclose every element of the claims or that the teachings of more than one reference may be considered in combination provided one of ordinary skill in the art would combine the references in that way to solve the problem facing the inventor. *KSR International Co. v. Teleflex Inc.* 127 S. Ct. 1727, 1734 (April 30, 2007). Applicants respectfully submit that the Examiner has not met that burden.

In various embodiments, the presently claimed invention includes measuring the quality of registration between a number of time-separated medical images, and in particular, calculating the quality of registration in a novel and inventive way. As the Examiner will appreciate, when a plurality of time-separated images are taken of a subject, it is possible that the subject moves between the images. In this case it is known to compensate for this movement by "registering" the various time separated images together, *e.g.*, aligning them and distorting them to compensate for the motion. There are various known ways to perform such motion correction, including searching for particular image features and then moving the images so that the identified image features are aligned in the series of images. Such motion correction is very useful, but it is regarded with some suspicion by clinicians, especially where the correction involves some deformation of the image (*e.g.*, stretching or shrinking rather than a simple translation or rotation).

In various embodiments of the present invention, the aim is to calculate a measure of the quality of the registration (*e.g.*, how accurate the motion correction is). This allows either the measure of quality to be displayed to the clinician, or the motion correction to be repeated, for example, at a finer scale, in regions of the image where the quality of registration is poor. One of ordinary skill in the art might think of obtaining such a measure of quality of registration by looking at the details of the registration process itself. In other words, one could examine the calculations performed in finding the similar image features, and look at how similar the features are or how well the features are aligned in the final image. However, in various embodiments of the present invention, a radically different approach is adopted. In various embodiments, the present invention calculates the measure of the quality of registration from the temporal behaviour of the imaged region, *e.g.*, how the imaged region changes over time. This is only possible where one has a model of the expected temporal behaviour of the imaged region, but where one does have such a model it is then possible to compare the temporal behaviour measured on the registered series of images with the model of the expected temporal behaviour. A level of agreement between the two can be calculated (for example by a simple subtraction of the data points from the expected curve as indicated

in Figure 3(c)), and this calculated level of agreement can be taken as a measure of the quality of registration. The point is that if the imaged region does not behave temporally as expected, in various embodiments, the present invention regards this as being indicative of a poor registration of the time-separated images. Obtaining a measure of the quality of registration from the temporal behaviour of time separated images by using a model of the expected behaviour is different from the cited prior art method of measuring quality of registration. Further, none of the cited prior art in particular Smith, Suri or Hossack measure quality of registration in this way. Thus, these references cannot anticipate the claims or render the present claims obvious.

With regard to Smith, this reference discloses a method of registering temporal contrast-enhanced images, and then at each point in the registered images a curve is plotted of the uptake of the contrast agent. This corresponds to the early steps specified in claim 1. These uptake curves are then compared to a series of models to determine whether regions are cancerous, suspect or normal. This is clear from paragraph [0072], lines 7 to 10 which say “... *the calculated pixel intensities may be compared with the data from the library 82 to conclude whether the tissue now under study is cancerous, suspect or normal.*” Thus, Smith does include a step of comparing the measured temporal behaviour with a model of the expected temporal behaviour of the imaged region. But this is to determine whether the tissue is cancerous, suspect or normal. Smith does not disclose the additional steps specified in amended claim 1 of measuring the quality of the registration of the time separated images. There is no disclosure in Smith of a measurement of registration quality. Further, Smith lacks the step in amended claim 1 of determining a measure of the quality of registration of the time separated images from said calculated level of agreement. Finally, Smith has no concept that the quality of registration can be regarded as being poorer when the calculated level of agreement is lower. Thus whereas Smith compares the temporal behaviour of an imaged region to an expected behaviour in order to classify the region as normal, suspect or cancerous, in contrast to Smith, in various embodiments, the present invention calculates the level of agreement and then determines a measure of the quality of registration from this calculated level of agreement. Smith does not have any concept of calculating a measure

of the quality of registration. Accordingly, Smith cannot anticipate or make the claims obvious.

With regard to Suri, this reference discloses a method of re-executing a registration process if a registration of time-separated images does not converge. In such a case of non-convergence the registration is repeated with down-sampled, down-sized, or further smoothed data. However Suri lacks the concept that the temporal behaviour of an imaged region can be compared with a model of the expected temporal behaviour in order to determine a quality of registration. Instead Suri relies on a lack of convergence of the registration technique in order to trigger repeat registration. Thus, Suri does not add to Smith the steps identified above that Smith lacks. Further, it is inherent in Smith that the registration results are assumed to be correct. This is because Smith compares a series of models to the measured result to determine whether a particular region is normal, suspect or cancerous. Smith is therefore directed to a method of classification. If, in Smith, the registration is wrong, the classification of regions as normal, suspect or cancerous will not work. Now further, with regard to Suri, Suri discloses re-executing registration in the case of non-convergence, in contrast, in various embodiments of the present invention registration is based on a comparison of the measured and expected temporal behaviour of the image, not on whether convergence has occurred or not. In various embodiments of the present invention, it may be the case that the registration process converges, but nevertheless registration is regarded as poor because the expected temporal behaviour is not found. It is therefore clear that in various embodiments, the present invention is basing its measure of quality on quite a different concept from Suri. Accordingly, Suri cannot anticipate or make the claims obvious.

With regard to Hossack, this reference discloses a method of motion estimation in ultrasound images for 3D reconstruction. Hossack does not add to Suri or Smith the concept that a measure of the quality of registration can be determined from a calculated level of agreement between the expected and measured temporal behaviour of the imaged region as currently claimed.

In summary, none of the cited prior art references disclose, among other things, measuring the quality of the registration of the time separated images and determining a

measure of the quality of registration of the time separated images from a calculated level of agreement. Therefore the cited references do not anticipate the claims and one of ordinary skill in the art upon combining the cited references still does not obtain the current claims. Accordingly, the claims cannot be considered anticipated or obvious and Applicants respectfully request withdrawal of the rejections.

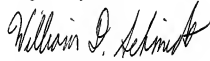
Conclusion

Reconsideration and allowance are respectfully solicited.

Enclosed is the fee for a one-month extension of time. No additional fee is believed to be due with respect to filing this amendment. If any additional fees are due, or an overpayment has been made, please charge, or credit, our Deposit Account No. 11-0171 for such sum.

If the Examiner has any questions regarding the present application, the Examiner is cordially invited to contact Applicant's attorney at the telephone number provided below.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "William D. Schmidt", written in a cursive style.

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